ENGINEERING EDUCATION

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Chas. F. Scott, Mortimer E. Cooley, F. L. Bishop, *Editor*.

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TABLE OF CONTENTS.

The President's Foreword 43
Editorial 46
Preparing the Engineer for the New Era. J. H. Dunlap 48
The Iowa Prony Brake. F. G. Higbee 65
Town Planning Education for Engineers. J. L. Crane, Jr. 68
Committees of the Society 72
College Notes 75
Book Reviews 79
Program for the Second National Conference on Highway Engineering and Highway Transport Education 81

PRESIDENT'S FOREWORD.

"That the modern college is in need of radical remaking is almost everywhere admitted. We live in a world which was unknown or undreamed of when the main characteristics of our colleges were determined."

We may well consider the significance of these statements if "Engineering School" is substituted for the word "College." Have not the changes which have come about in the modern world, largely through the results of the engineer and his work, been so sweeping they may be said to have been "unknown and undreamed of," when our engineering schools were established? Just what are the conditions which confront the engineer today and what will they be in the next generation? What must our engineering schools do to anticipate the future so that the men trained today can meet the demands of tomorrow? These are fundamental and profound questions. They involve, not merely engineering as practiced in the past or the present, but call for an ideal which engineering should fulfill in the future.

To direct attention to such questions as these and, perchance, to contribute something to their solution is a function of the plan proposed by the Development Committee whose report was printed in the last issue of the BULLETIN.

A feature in the minds of the Committee which is possibly not sufficiently emphasized in the wording of the report is the importance of a general consideration of the broad problems of engineering education by the schools themselves. What is proposed is not separate and apart from the schools but is to be vitally connected with them. Many schools have been studying these problems to determine how their instruction may be modified to produce more competent men. Various changes and innovations have been made. Far from being a reproach it is the normal condition of progress. The engineering mind al-

ways seeks a better way. Each experience serves as a stepping stone for something better next time. In engineering education this is doubly necessary as the conditions to be met and the objectives sought are continually changing.

While it is of the first importance that the individual teacher and the individual school should continue and profit by the study of vital questions of engineering education there should also be a broad and general consideration of the subject. The modern method is coöperation and there should be a coördination of the work of the various schools which may be helpful and inspiring. A function of the Board proposed by the Development Committee is to perform this very function. It is not to take away the responsibility of the individual school in its study of the general problem, but it should rather increase the interest and the activity of each in dealing with its own particular problems and in joining in the common national problem which lies before engineering education as a whole.

The Board will welcome the aid of individuals and of faculties in making definite plans for carrying out the work it has before it.

EDITORIAL.

The Board of Investigation and Coördination recently appointed by President Scott of the Society upon the approval of the Council, will have before it many important and far-reaching questions. One of these naturally is what new fields will be open for the engineering graduate in the near future? One of these fields which the engineering schools have almost entirely overlooked is that of transportation.

Mr. Ford, in a recent interview, stated that there were three arts, agriculture, industry and transportation. It is evident that the success of the first two is dependent upon the last, but have we as engineering teachers given this latter field the prominence which it deserves? Following the Morrill Act of 1862, there were established in this country colleges of agriculture. There is a great Department of Agriculture in Washington. The country has been taught how to grow two blades of grass where only one grew before. We can feed the world. The engineering schools were established at practically the same time and the development in industry in this country can be measured by the growth and development of the engineering schools. We now lead the world in many of our manufactured products and could in all. But what is the use of making two blades of grass grow where only one grew before, if there is no means of shipping the first blade to its market? It is a notorious fact that in certain sections of this country fruit is given away due to lack of transportation facilities. Industry is hampered. Sections of the country may suffer from the cold due to the lack of adequate and proper transportation systems. Even the urban transportation systems have fallen down under the pressure brought about by the concentration of population in relatively small areas. Is it not time for the engineering schools to give to this important subject at least the same attention that we give to the develop-

ment of other departments, for instance, the electrical engineering? All of our engineering schools have large electrical engineering departments. This art has developed with great rapidity until today American stands preëminent. But how is it with transportation?

A report presented at the June meeting of this Society showed that there was only one professor of highway transportation in the country. The seriousness of this matter was recognized by the Commissioner of Education in calling together a group in Washington in the spring of 1920, to discuss the subject of highway engineering and highway transportation. Out of this grew the Highway and Highway Transport Education Committee. This is now known as the Highway Education Board. A great conference is called in Washington by the Commissioner of Education for October 26, 27 and 28, at which time many notable speakers and many representatives of engineering and economic colleges will be present. The subject will be discussed in a broad way and fundamentals outlined. This will certainly call our attention to the vital part which transportation plays in our lives. This Society is represented on the Highway Education Board by the Secretary. At this writing over 100 universities and colleges have accepted invitations to send representatives to this conference. The educational men will join with men from industry and with practical men from transportation fields in an attempt to solve some of the difficulties underlying this form of transportation. A study of the preliminary program in this issue of ENGINEERING EDUCATION shows to some extent the character of the work undertaken in this field.

PREPARING THE ENGINEER FOR THE NEW ERA.

BY JOHN H. DUNLAP,

Professor of Hydraulics and Sanitary Engineering, University of Iowa, Iowa City, Iowa.

Introduction.

As president of the Iowa Engineering Society during the past year, I found it my duty to visit the district clubs, located in the principal cities of the state. By way of explanation it should be said that when the Iowa Engineering Society was recently reorganized, the principle of consolidation of the existing local engineering clubs with the state society was decided upon, rather than the more usual plan of affiliation. In other words, under the Iowa plan the members of the local engineering clubs are also members in the same grade of the state organization. What I have to say on the subject now before us, preparing the engineer for the new era, has for the most part grown out of the experiences occasioned by the visits to these clubs.

The New Era.

One of the conclusions reached in the course of these visits was that we engineers have been so busy making the world over that we are scarcely aware that a new era has dawned, a mechanical era, the era of the engineer

In fact, during the late war we seemed surprised to discover the extent to which modern warfare has been transformed into a conflict between various kinds of engineering units. The aëroplane, artillery, poison gas, the motor transports, highways, railways, water supply outfits, the manifold means of communication, battleships, army transports, the submarine, the depth bomb, the torpedo, all these are in large part the work of the engineer from the time the original materials are pro-

duced in the mines even to the field operation of the completed paraphernalia.

Moreover, we have been slower in peace, even than in war, to realize the extent to which mankind is dependent upon engineering structures and machines. To illustrate how generally we have changed the habits of life of the world, we have in imagination but to consider a day's work. On getting out of bed—of course before sunrise—we first push a little button somewhere on the wall and instantly the room is flooded with light. Think of the long line of researches in the principles of applied science which have made possible this creation of the electrical engineer, the electric light. Then we take the morning bath. Every fixture in the bathroom is a product of great industries calling for the exercise of the best talent of many types of engineers. In dressing for breakfast, we don the clothes made possible by machinery almost human in its delicacy of adjustment and fineness of product, machinery which is the work of many engineers, mechanical, electrical, mining, chemical, and industrial among the rest. Nor should we forget the marine engineer, for in all probability the material for some of the garments we wear has been imported from Australia, South America, or more distant quarters of the globe. But next we sit down to breakfast. Our grapefruit comes from Florida, our oatmeal from Iowa, the sugar from Cuba, the bacon from Chicago, the flour for the toast from Minnesota, coffee from Java, the china from France, the silver from Mexico, and the linen from Ireland, all brought to our door by great transportation enterprises involving engineering units of many types. After breakfast we go out to the garage and start the car. Of course the modern automobile is a combination of engineering units. If engineers had developed nothing else but the internal combustion engine used in this machine, they might feel that they had accomplished a good deal for the betterment of mankind. Or, if we prefer, we may take the trolley car, and profit by the work of the electrical engineer and the many other types of engineers associated with him in putting at our service this modern convenience.

In going down to the office we speed along over pavements again the work of the engineer, beginning with those who have supplied the materials and made possible their manufacture, and ending with those who have designed and supervised the construction of the pavements. And in fact the streets themselves along which we ride should be a part of a comprehensive city plan, in the laying out of which the engineer has had the lead. As we pass building after building we are continually faced with the necessity of a building code, which must be largely the work of our profession. At the office we lose contact with the engineer during scarcely a moment of the day, for at every turn the convenience of the machines he has made possible, and of the many devices he has created, is continually at our service.

As a result of this transformation of the world into a mechanical world, an engineer's world if you will, an entirely new set of problems is arising, in the solution of which the engineer has an opportunity to render distinguished service. In fact, some of our great transportation systems are already calling the engineer to positions of high executive responsibility. For instance, the Pennsylvania Railroad has recently selected its presidents from men whose early training had been in the engineering staff. Likewise, our manufacturing plants are beginning to rely upon the engineer more and more, a natural thing to do since a manufacturing plant is usually composed of engineering units, an intimate knowledge of which is a decided asset in their management. For example, the president of the largest washing machine company in the world is L. P. Maytag of the Maytag Company of Newton, Iowa, a graduate in mechanical engineering at Iowa State College. With reference to his early engineering training, Mr. Maytag makes this interesting statement, that "since in the study of engineering the very essence of any problem is the demand for a reason why, it would be a wonderful thing if every student could have a certain amount of engineering education, and the more the better."

Not only are our transportation and industrial systems beginning to realize the service which the engineer is equipped to render in executive positions, but also of late our municipalities have more and more acquired the habit of turning over the control of their affairs to city managers, a large majority of whom are engineers.

Of many possible examples of the services of the engineer in the new era, only one will be cited. Herbert Hoover is said to be one of the few great mining engineers of our generation. In the practice of his profession he has acquired wealth. Moreover, he is a past-president of the American Society of Mining and Metallurgical Engineers and has written a book, "The Principles of Mining." Is it not significant, however, that during the late war the trained genius of Mr. Hoover, the engineer, saved more than once whole civilian populations from starvation and, in so doing, incalculably strengthened the battle lines? And now, as Secretary of Commerce, Mr. Hoover is wrestling with the problems of the new world, an engineer using the method of applied science in the study, and in the solution, of our industrial questions.

The Present Preparation.

In view of these facts, not only because of the surprising extent to which we engineers have rebuilt the world, but also because of the enlarged service which our profession is now being asked to render in solving the problems of the new era, we must conclude that a heavier responsibility than ever before now rests upon the institutions which are entrusted with the important task of preparing the engineer for his life work. We have the right to expect that the engineering colleges, sensing their great duty to mankind, shall have determined to maintain their leadership of a generation ago, to the end that our profession may be the best prepared of all the professions. But, due in large measure to our failure to understand the imperative needs of a new day, we have allowed our engineering colleges to lose their former leadership. At our

annual meeting at Ann Arbor two years ago I called your attention to* the following disheartening statistics. In the school year of 1898–99 only 14 per cent. of the medical schools required for admission more than a one-year high school course, as compared with 33 per cent. of the law schools, and 80 per cent. of the engineering schools. Moreover, 91 per cent. of the medical schools had a four-year course, with an average of 28 months in attendance, as compared with 98 per cent. of the engineering schools, with an average of 35 months in attendance. The law school course was much briefer than that of either of the others. Accordingly, twenty years ago, the requirements for admission to engineering schools, as well as the length of course, greatly exceeded those of the law and the medical schools.

The same test applied at the present time shows results decidedly unfavorable to the engineering schools. The medical schools, twenty years ago at the bottom, are now at the top; while the engineering schools, twenty years ago at the top, are now at the bottom, with the law schools in a middle position. Furthermore, the leading dental colleges began to require in 1921 one year of liberal arts college credit for entrance to the four-year dental course. Moreover, the graduation requirements of the leading schools of theology now consist of a four-year liberal arts course plus a three-year theological course. Accordingly, engineering colleges requiring four years of study in addition to a four-year high school course are now fifth on the list of professional colleges. Indeed, it is very doubtful if they should be classed as professional colleges at all.

Furthermore, you will recall that at the annual meeting at New Haven last year, Professor W. H. Burr declared the present curricula in our engineering colleges to be behind the times. We will not rehearse his arguments here, since they are scheduled for discussion at a later session of this meeting.

* *Proceedings of the Society for the Promotion of Engineering Education*, Vol. 28, 1921, pp. 128–136.

Specifications for the Future Preparation of the Engineer.

"But," I hear you object, "mere statistics and assertions do not demonstrate that our engineering colleges have not kept step with progress." In reply, we must admit that statistics and opinions in regard to so complicated a matter as the education of the engineer are of limited value, and that the real criterion is the product which our engineering colleges should produce, if the engineer is to occupy the position of leadership rightfully his, in a world fast being transformed into a vast collection of engineering units upon the proper functioning of which the welfare of humanity depends.

But to write specifications for this human product is not easy. In the* Bulletin for May, Professor Frank H. Neff suggests the following list of desirable qualities: kindliness, modesty, energy, patience, perseverance, honesty, a trained mind, thoroughness, accuracy, capacity for details, and breadth of judgment. This list, however, good as it is for the engineer, fits equally well any type of educated man.

To be sure, Arthur M. Wellington as long ago as May 11, 1893, in one of three editorials in *Engineering News*† on "The Ideal Engineering School," set forth a list of six acquirements to be expected of an engineering student upon graduation. These acquirements may be summarized as follows:

1. A good common school or high school education.
2. Ability to look oneself in the face and not be ashamed.
3. Practical gumption, and physical vigor; mental calmness and keenness.
4. Ability to appear always at one's best.
5. A book knowledge of engineering.
6. Some practical knowledge of engineering.

It should be noted that four of these six acquirements apply

* "Specifications for a Teacher of Engineering," by Frank H. Neff, Professor of Civil Engineering, Case School of Applied Science, Engineering Education, Vol. 12, May, 1922, pp. 403–406.

† *Engineering News*, Vol. 29, 1893, p. 445.

equally well to anyone, while only the last two apply peculiarly to the engineer.

Moreover, in 1918, Charles R. Mann* reports in his "Study of Engineering Education" that he sent to the 30,000 members of the four founder engineering societies a list of six groups of qualities headed by character, judgment, efficiency, understanding of men, knowledge, and technique. He requested that the list be returned with these six qualities numbered in the order of their importance in determining success in the engineering profession. In the seven thousand replies which were received, the character group was voted a place at the head of the list almost unanimously, while technique was voted a place at the bottom of the list. Now, while we will all agree as to the importance of character, yet we all know that without a proper mastery of technique, an engineer is a failure. In other words, such a discussion is as fruitless as a hypothetical argument between the mainspring and the hairspring of a watch. As a matter of fact the watch will not run without both mainspring and hairspring acting in perfect synchronism. Furthermore, to say to an engineering college that character is important without indicating the educational process by which the college may develop character, is not of any very great assistance.

In the following ten specifications for the product of our colleges, an attempt has been made to specify the sources from which character springs, in so far as the engineering college is concerned. The order in which the ten specifications will be given should not be misunderstood. For myself, I believe that no one of the accomplishments to be specified can be omitted from the future preparation of the engineer without failure resulting. The first five specifications are general, and represent acquirements which every man should have who calls himself educated. The last five specifications are more techni-

* "A Study of Engineering Education," by Charles R. Mann, 1918, Bulletin No. 11, The Carnegie Foundation for the Advancement of Teaching, New York.

cal, and represent the additional acquirements peculiarly necessary for the engineer.

1. Every educated man shall know his environment.

Now to know one's environment in this, the new era, is no small task. It requires an understanding of the principal facts of at least the following divisions of knowledge: history; biology, geology, and astronomy; mathematics, physics, and chemistry; sociology, political science, and economics. Of course it would be impossible for everyone to cover the details of these branches of knowledge as they are now presented, for the most part, in our curricula. A readjustment of our present watertight compartment system of departmental organization would have to be made, with the end in view of serving the needs of students in a closely related educational program.

The necessity for such a background in any educational plan is self-evident. For example, if William J. Bryan knew the facts which science has revealed in regard to our environment, we would not now have the unhappy spectacle of the Great Commoner traveling about the country seeking, as the newspapers report, "to win votes for God, instead of votes for apism."

2. Every educated man shall know himself.

Self, in the sense here used, has the broad meaning which includes not only the individual ego, but also that wider circle of things and people which act and react upon the individual. For a man to know himself, he must know those great storehouses of human thought and aspiration, literature, music and art. He must know the principal facts of philosophy and of psychology. He must understand that the physical ideal is health; the intellectual ideal, truth; the emotional ideal, beauty; and the volitional ideal, goodness, in all three of its aspects, personal, social and vocational. The task today of knowing self is far more difficult than in

the days when to "know thyself" became the ideal of the young Greek. And yet many of our graduates do not progress as far even as the standard of the Greek, to say nothing of that early Hebrew discovery in psychology, expressed by the facile writer of the wonderful book of Job, when he said, "The fear of the Lord, that is wisdom; and to depart from evil is understanding." Illustrations of the failure of modern education in these respects are all too easy to find. For example, I have had an experience for the past few weeks with a graduate student, who was virtually paroled to me by the administration, which has made me very thoughtful concerning a system of education which permits a man to graduate, and even to become a graduate student, who is still a child so far as his knowledge of himself and of his environment is concerned.

3. Every educated man shall think well.
4. Every educated man shall write well.
5. Every educated man shall speak well.

It would seem as though these last three specifications were sufficiently axiomatic so that our educational process would insist upon them. If one really wishes to know, however, how little attention is being paid to these accomplishments in our engineering courses at the present time, he should serve for several years as secretary of a good-sized engineering society. Such an experience would lead one inevitably to the conclusion that a pitiably small percentage of engineers can think well, write well, or speak well.

6. To change from the general to the specific, every engineer shall know the sources of scientific information. He should be perfectly at home in libraries, and find it no small pleasure to be able to determine what has been written upon any subject in which for the time being he may be vitally interested. In this connection your attention should be directed to an excellent article* in

* "Instruction of Students in the Use of the Technical Literature; an

the BULLETIN for May, by E. H. McClelland, Technology Librarian, Carnegie Library of Pittsburgh, on the subject, "Instruction of Students in the Use of Technical Literature; an Unexpected Phase of Engineering Education." Your attention is also called to the excellent course of this character now being conducted here at the University of Illinois for the students in chemical engineering, under the direction of Miss Sparks.

7. Every engineer shall be skilled in the use of the method of applied science in the solution of engineering problems. Of course he must first master the fundamental principles of applied science to the extent to which they are the tools of the engineer. It is right here that the line is most sharply drawn between the engineer and the physicist, between the applied scientist and the scientist. The physicist needs only to know the fundamental principles of science, while the engineer must not only know them, but also know how to apply them.
8. Every engineer shall be thoroughly trained in costs and values. One definition of an engineer is that he can do for one dollar what anyone can do for two. In almost all engineering work the final control, both of design and of construction, is cost. In spite of costs and values being of controlling importance, very little of scientific worth concerning them is to be found in our textbooks, or in our magazines. For instance, even the *Engineering News-Record* still persists in reporting the bids received in such a way as to be of little use to the engineer. Take this case in the issue for June 8.

BIDS RECEIVED.

Maple Heights, Ohio—For 14,735 ft. 4–10 in. mains in Dunham, Rockside, Kohout, Raymond and Royal Sts., from J. H. Dace, 1452 West 98th St., Cleveland, $40,816; W. McDowell & Son, 10319 Miles Ave., Cleveland, $45,514.

Unexploited Phase of Engineering Education, by E. H. McClelland, Technology Librarian, Carnegie Library of Pittsburgh, ENGINEERING EDUCATION, Vol. 12, May, 1922, pp. 407–420.

It is readily seen that from such a notice no knowledge whatever can be gained of the price per foot for different diameters of main, or of the depths and the conditions under which the pipe was to be laid.

A few days ago I was talking about engineering education with the head of the leading firm of structural engineers in the state of Iowa. His comments upon the lack of attention paid to costs in our engineering colleges were emphatic, to say the least.

9. Every engineer shall prove himself to be an economic asset in his work, and shall understand the commercial and ethical aspects of professional practice. Throughout his entire college course he should be taught to look upon himself as one who by his peculiar skill can save his employer much useless expenditure, no matter whether his employer be a private individual, or a group of individuals like a county board of supervisors, a city council, or the public in general. Recently throughout the state of Iowa we have had an epidemic of so-called taxpayer's leagues, which have professed to believe that the county engineers and the highway engineers of the state, instead of saving the public vast sums of money, were viciously engaged in wasteful and extravagant practices.

10.

Moreover, many of the counties in the state of Iowa are so little convinced that an engineer is an economic asset to them, that they do not hesitate to advertise for bids for engineering services, and to accept the lowest bid. Only a few weeks ago such a case occurred in one of the counties of the state. The secretary of the Iowa Engineering Society, learning at the last minute what the county was planning to do, sent the county auditor a letter which arrived at the moment the bids were being opened. Therefore, as the bids were opened and read, so also was the letter from the secretary opened and read. Part of this letter was as follows:

> Your county engineer is a vital factor in the conduct of the affairs of your county, and upon him de-

pends a great deal how much money is saved to your county in carrying out the road program. It is considered unethical among the best class of engineers to submit bids on the basis of salary, and for this reason your county, more than likely, will not get the best engineering services. The best engineer you can get should save your county more than his salary in any year. If he cannot, he has very little excuse for existing. With these facts in mind you will see that it is to your interest to employ your engineer on the basis of his fitness for the position.

Strange to say, the board of supervisors was so impressed by this letter that they rejected all bids and reemployed their former county engineer. It is safe to say that this situation would never have developed if this county engineer had been taught, in his college days, to look upon himself as an economic asset to his employer, and if he had been taught the necessity of proving to his employer from time to time that he was able to save him money. Anyone who does not enjoy cost data, whether applied to work under construction, or applied to his own job, is probably out of place in the engineering profession.

10. Every engineer shall be taught throughout his college course that one of his chief functions in life is to serve his community. Recently I had the opportunity of asking Dr. Edward T. Devine, America's leading applied sociologist, in what direction he considered the greatest hope of our municipalities to lie. In substance he said at once, in the direction of the application to community affairs of the abilities of technically trained men. Probably Senator King had in mind the same opportunity for service when, as one of the speakers at the annual dinner of the Society of Engineers of Washington, D. C., December 7, 1921, he said that the country would be benefited if the existing United States Senate should resign and each place be filled with an engineer. In a ringing, national call to service, President Harding on June 9, at

the dedication of the Princeton Memorial to the Army of 1776, is reported to have broken away from his prepared manuscript, and to have declared:

> I care not what position a man may momentarily be in. You can measure his standard of usefulness to America by the service rendered to the community in which he resides.

In spite, however, of the manifest opportunities for service in our communities, composed as they are today principally of engineering units, our engineers are not occupying their rightful positions of leadership. For instance, at an evening dinner some time ago, I chanced to sit beside a woman who was a leader in the community affairs of her home town, a small county-seat of less than four thousand population. Knowing the county engineer, I ventured to inquire if she was acquainted with him. Imagine my surprise to learn that she had not yet heard of him. As a sequel to this story, it should be added that a few weeks ago this county changed county engineers.

Of course part of the trouble at present is that the training of the engineer is so narrow that he feels himself uncomfortable and embarrassed when he attempts to help in public affairs. If the major part of the above specifications could be carried out, the engineer would find himself, as the years of practical experience came to him, the best prepared man in his community, and as a natural result, would assume leadership. While this is of course important from the aspect of its bearing upon the relative standing of the engineering profession as compared with the other professions, yet it is still more important, when viewed from the standpoint of the community itself, and its need of men skilled in the method of applied science.

"But," you inquire, "are not these specifications already very well carried out in our engineering curricula?" In reply, I believe the answer must be made that the first five specifica-

tions, which are really essential to every man who calls himself educated, are for the most part ignored in our present engineering courses. Of the last five specifications which are intended to apply particularly to engineers, only one of them now receives careful attention, namely, the seventh, that every engineer shall be skilled in the knowledge and in the application of the fundamental principles of science. Now of course the other nine specifications may be carried out after graduation with complete success, and some engineers have forced themselves to find time for this. For the most part, however, the young graduate finds himself so busy for the first ten years in furthering his knowledge of the technique of his profession that he has little time for other study. Except for the successful few, therefore, some substantial progress in these ten objectives in the preparation of the engineer for the new era must be attained before graduation.

The Time Required.

To cover the ground outlined, in all probability the course will have to be lengthened to five, and eventually to six years, although a great deal of time can be saved by certain modifications of the existing four-year course. In this connection it should be noted that as long ago as 1871, General Sylvanus Thayer, who is known as the father of the United States Military Academy, came to the conclusion that a six-year course was necessary. Accordingly he founded the Thayer School of Civil Engineering at Dartmouth College. He stipulated that, after a complete college course of four years in Dartmouth College, a two-year course was to be given in the Thayer School in the advanced courses of civil engineering. For twenty-two years this plan was followed, until in 1893 increased coöperation between Dartmouth College and the Thayer School made possible the adoption of a five-year program, three years of which are given in Dartmouth College and two in Thayer School. You are of course familiar with the unfortunate ex-

periments in lengthened curricula made at other institutions. At the present time the five-year course at the Thayer School and the six-year course at Columbia University are the principal exceptions to the four-year plan. Naturally the recent conference at Chicago of the fourteen deans of middle-west colleges leads us to hope that better days are dawning for engineering education.

But it would probably be unwise to require all the students who begin an engineering course to take the entire five or six years. A better plan would be to adopt a two-stage method, somewhat similar to that by which engineering is now taught in France and Italy. To quote from the excellent report of the Committee on Technical Education of the Mining and Metallurgical Society of America:*

In France and Italy engineering is taught in two stages. The more advanced stage which aims to turn out actual engineers of training, ability, and power, is open only to those who have proved their right to enter it by conspicuous ability and fitness in the first stage. And the first stage, though preparatory to the second, is so designed that the majority whose college career ends with it are not turned loose as two-spot engineers, yet ill-fitted by training and because of pride to do anything else. Instead, they are equipped to step into positions of intermediate responsibility, where they do high-grade work with entire self-respect.

This suggests that the first four years of an engineering course be so planned as to fit men with no particular engineering ability to assume the subordinate positions in industry. The regular college degree of B.S. might be given at the conclusion of the four-year period. Then those who have shown themselves fitted for advanced technical work in engineering should be encouraged to enter the fifth, or the fifth and sixth years of the complete course, from which they might be graduated with the professional degree of C.E.

* Bulletin No. 150, Vol. 14, September 30, 1921, p. 175, Report of the Committee on Technical Education, Mining and Metallurgical Society of America, New York.

The Challenge.

We should not be alarmed at the suggestion of increasing the length of course, in order to prepare the engineer more adequately for his work in the new era. One year was sufficient during the early history of the Rensselaer Polytechnic Institute, at which the civil engineering course was established in 1829. We have, therefore, already added three years to the course, and should expect to add more as science expands. The horizons of knowledge are being steadily pushed farther and farther back. Geology was not born until 1830; organic evolution, until 1859; the germ theory of disease, until 1876; and the wireless telephone, until very recently. Contemporaneously with these accomplishments the engineer has been making the world over until we are now in the midst of a mechanical age. Notwithstanding this fact, we have allowed the preparation of our engineers to lag behind the preparation for the other professions, and actually to lose the position of leadership occupied twenty years ago. Dean Mortimer E. Cooley, past-president of this society, recently expressed it in this way: "The engineer a generation ago was better prepared to do the work of his generation than is the engineer of today prepared to do the work of this generation."

In view of the need of this country, and in fact of the world, for the services of men skilled in the method of applied science, it would seem that we should insist that the engineer be the most carefully prepared man of our generation. He should know his environment and know himself; he should think well, write well, and speak well; he should be familiar with the sources of scientific information; he should know the fundamental principles of his calling and their application to the work of his profession; he should understand the controlling importance of costs and values, and himself become an economic asset wherever he goes; and he should lead in every type of service that goes to upbuild not only his community, but his nation, and the world as a whole. Even as science and industry today are international, so should be the thinking

of the engineer. The new era flings a challenge to him, a challenge with dimensions limited only by the life of humanity itself. Let us as teachers do all in our power to prepare him to accept the challenge, and to perform worthily his important part both in the material, and in the spiritual, evolution of civilization.

THE IOWA PRONY BRAKE.*

BY F. G. HIGBEE,

Professor of Descriptive Geometry and Drawing, University of Iowa.

Conceived in the University of Iowa Electrical Laboratory, designed by Iowa students in drawing, constructed by Iowa students in the Engineering Shops, and finally tested by Iowa electrical engineering students, the "Iowa Prony Brake" is an excellent example of coöperation and coördination of students working in different departments toward a common end, as well as an interesting development in electrical testing apparatus.

For some time the prony brakes in the electrical laboratory have been giving trouble. Bearings burned out, too frequent oiling was demanded, too much vibration was present, all due to poor design of the brakes in use. Professor Arthur H. Ford conceived the idea of a ball-bearing brake and turned the idea over to a special class in machine drawing for development. The problem was studied by five men, under the general direction of the writer, and the idea as developed by them was then returned to the Electrical Engineering Department for criticism and revision.

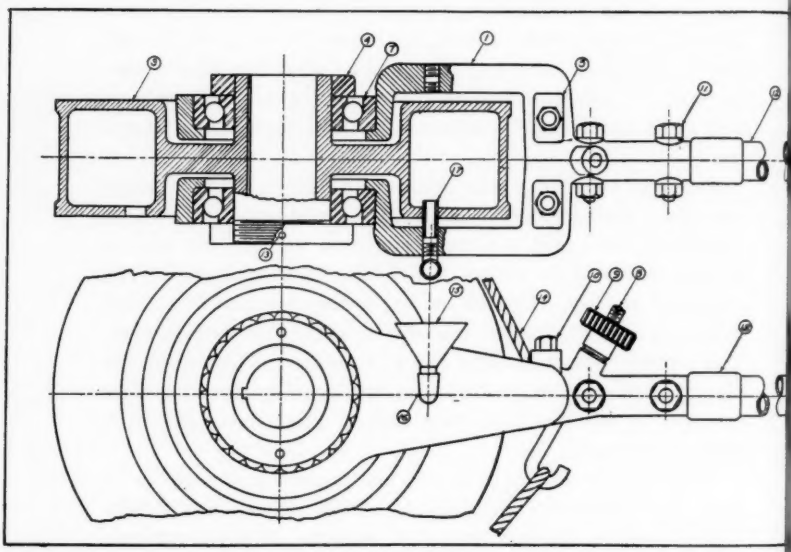
The tentative design, as revised and improved by suggestions from the Electrical Engineering Department, was finally turned over to another group of machine drawing students under Prof. Thos. G. Caywood for detailing. The set of details finally selected was worked out by Mr. Carl Arvidson of the Electrical Engineering class of 1922, was checked by Mr. J. R. Eyre, instructor in Electrical Engineering, and was sent to the shops for production.

Under the general direction of Mr. A. V. O'Brien, Superin-

* Revised from an article in *The Transit*, a journal published by the Engineering Students at the University of Iowa.

tendent of the Shops, the patterns and castings were made and sent to the machine shop for finishing and assembly. The general design of the brake involved some work which was rather difficult to machine and required very particular handling. When complete, the brake was sent to the Electrical Laboratory for testing and, after a few minor adjustments, was put into service as a regular part of the laboratory equipment.

The accompanying drawing will give a general idea of the

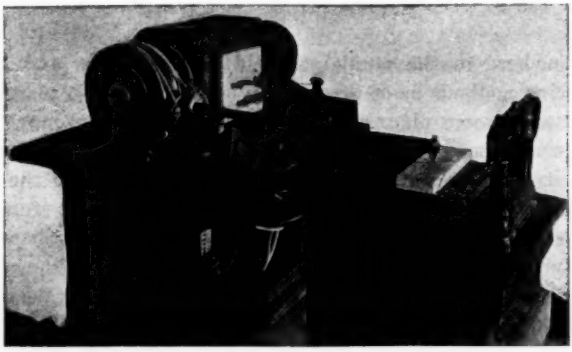


construction of the brake; the photograph, taken when the brake was in actual service running at 3,000 R.P.M., shows how it is connected with the motor, and that in operation it is free from vibration.

During the current year still another group of machine drawing students under Professor Caywood is at work on modifications of the design and it is expected that some of the manu-

facturing difficulties encountered in making the first brakes will be eliminated.

In addition to furnishing the Electrical Laboratories with a distinctive and improved piece of measuring apparatus, the design and production of this prony brake have given a large



group of students an interesting and practical problem.

The several departments in the College which coöperated in the design and construction of this brake will be glad to furnish working drawings without charge and gray iron castings at cost to any electrical laboratory desiring a brake of this type.

TOWN PLANNING EDUCATION FOR ENGINEERS.

BY JACOB L. CRANE, JR.,
57 W. Monroe St., Chicago, Ill.

Nowhere in the municipal field can engineers and engineering methods be of greater service than in town planning. But some town planning has been badly done and much has gone undone, because engineers lack the training needed to realize, and to fulfil efficiently, the possibilities of the art.

Town planning is nothing less than planning for the orderly evolution of the community in its several phases of activity. It should be the expression not only of the city's present social organization, but also of its future possibilities in social organization. The civic survey, which furnishes the foundation for the actual planning, involves a canvass of the needs, aspirations, resources and limitations of the community—not physical alone but social, political, and economic as well. The beautification of the city, which is sometimes thought of as the whole of city planning, is only one element of the plan, although competent attention to the other factors will tend to make a beautiful city. Public recreation, housing reform and building regulation, zoning, public health, public services (water supply, sewerage and sewage disposal, wastes collection and disposal, street maintenance, gas, light, transit, etc.), block and lot planning, the development of civic centers, streets and transportation facilities, waterways, even public education and finance are all intimately involved in the sound plan. And perhaps the most important function of town planning is the coördination of all these civic activities for the future progress of the town, the relation of them one to another with a just and economical emphasis on each. Town planning, instead of being an expensive luxury, as it is regarded in some quar-

ters, intends to realize the town's progress more rapidly and at the same time more cheaply than would be possible without comprehensive planning.

In many of its aspects, then, town planning is purely an engineering enterprise, and it requires the engineer's services from beginning to end. Engineers will undoubtedly be called upon to draw many town plans, alone or in conjunction with an architect, a landscape architect and an assisting sociologist. In interpreting and executing the plans, in the actual field development, the municipal engineer will often act alone. In this work lies one of his finest opportunities. But a review of the field of town planning shows deficiencies in the training of the student of municipal engineering. Many essential factors of town planning are not included at all, and the whole matter of coördination in planning for the future is scarcely touched. Men who propose to go into town planning professionally would benefit greatly by a sub-department in the school of civil engineering, with additional courses in architecture, landscape architecture, and possibly sociology. This sub-department could offer the work desired both by non-professional students interested in town planning or civic development, and by men going into the specialized branches of municipal engineering, whose courses are too crowded to permit of more than a general study of town planning. Short of a separate sub-department, a general information course in the principles of town planning might be offered to all students interested in municipal development, with additional more intensive work for those who will be called upon, as municipal engineers or city engineers, to make, interpret, or carry out comprehensive town plans. These courses would be most valuable as graduate work.

In many colleges and especially in state universities, equipment in town planning could offer particularly useful service through the extension work of the school, and through the maintenance at the university of a permanent exhibi-

tion and library. This would both stimulate work for professional town planners and help the other departments of the University, and state and city officers, in their progressive public work.

As the fine possibilities of town planning are realized in the engineering schools and as opportunities develop for specially trained men, it is to be hoped and expected that more of the progressive schools will offer facilities for the required training. No work of greater interest could be offered to the students.

The most suggestive committee report on engineering education in recent years is that of the Committee on Technical Education of the Mining and Metallurgical Society of America. The report begins with a chart which outlines the field of mining engineering. Then an exhaustive analysis of existing curricula is presented. The discussion of what to teach and how is aimed straight at two weak spots: first, the inadequate correlation of courses; and second, the lack of standards by which to measure results. The development in the technical school of the power of independent investigation is declared to be one of its very highest functions, and the practice of omitting the thesis is deplored. Specialization is discouraged and a broad training in the fundamentals urged. The members of the committee were A. H. Rogers, Chairman, L. C. Graton and H. A. Guess. The report was published at the office of the Secretary, 115 Broadway, New York, and is known as Bulletin, Number 150, September 30, 1921, Vol. XIV, No. 7. We venture to suggest that any one interested in engineering education would be amply repaid for making a thorough study of this valuable report.

The following quotation is illustrative of the content of the report.

"In France and Italy, engineering is taught in two stages. The more advanced stage, which aims to turn out actual engineers of training, ability and power, is open only to those who have proved their right to enter it by conspicuous abil-

ity and fitness to the first stage. And the first stage, though preparatory to the second, is so designed that the majority whose college career ends with it are not turned loose as two-spot engineers, yet ill-fitted by training and because of pride to do anything else. Instead, they are equipped to step into the positions of intermediate responsibility, where they do high-grade work with entire respect."

(Signed) J. W. DUNLAP.

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1. Executive Committee: C. F. Scott, Chairman, Yale University, New Haven, Conn.; W. O. Wiley and F. L. Bishop.

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Study of the methods of admission to engineering schools, including European schools.

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17. Committee on Electrical Engineering: H. E. Dyche, Chairman, University of Pittsburgh, Pittsburgh, Pa.; F. A. Fish, T. R. Rosebrugh, and P. H. Daggett.

18. Committee on Mining Engineering: H. H. Stoek, Chairman, University of Illinois, Urbana, Ill.; F. H. Probert, F. W. Denton, and F. W. Sperr.

19. Committee on Drawing: R. S. Kirby, Chairman, Yale University, New Haven, Conn.; T. E. French, W. N. Barnard, and E. C. Chillman.

20. Committee on Standardization of Technical Nomenclature: J. T. Faig, Chairman, Ohio Mechanics Institute, Cincinnati, Ohio; W. D. Ennis, S. E. Moss, R. L. Daugherty, and J. E. Emswiler.

21. Committee on R. O. T. C.: P. F. Walker, Chairman, University of Kansas, Lawrence, Kans.; A. Marston, W. E. Mott.

22. Committee on Intelligence Tests: L. L. Thurstone, Chairman, Carnegie Institute of Technology, Pittsburgh, Pa.; Wm. T. Magruder, and C. R. Dooley.

23. Committee to Coöperate with National Engineering

Societies: D. C. Jackson, Chairman, A. I. E. E., Mass. Inst. of Technology, Cambridge, Mass.; J. C. Tracy, A. S. C. E.; F. W. McNair, A. I. M. & M. E.; Arthur M. Greene, A. S. M. E.

24. Committee on Engineering Experiment Stations: C. S. Howe, Chairman, Case School of Applied Science, Cleveland, Ohio; P. E. Walker, F. L. Bishop, R. H. Fernald, and J. F. Hayford.

25. Committee on Licensing Engineers: C. S. Howe, Chairman.

COLLEGE NOTES.

Carnegie Institute of Technology.—E. B. Phillips has been appointed Instructor in Electrical Engineering. He is a graduate of Georgia Institute of Technology, class of 1917, and for the two years following was an electrical engineer with the Western Electric Company, in New York City. During the past two years, Mr. Phillips has been instructor in electrical engineering at the United States Naval Academy, Annapolis, and at Georgia Tech.

Another important change in the Department of Electrical Engineering at Carnegie Tech next year will be the retirement of Professor A. J. Wurtz from the staff of the department. Beginning next fall, he will devote all of his time to research work in electrical engineering for the Division of Coöperative Research, continuing research work he has been doing on a part-time basis in the College of Engineering.

The acquisition of Professor Wurtz to the Research Division is of particular interest to electrical engineering companies, because of his contributions to the development of electrical engineering. He is the discoverer of the five non-arcing metals, and has made many notable inventions during his career.

Pennsylvania State College.—Arthur J. Wood, Professor of Railway Mechanical Engineering at The Pennsylvania State College, has been apponted to succeed Professor E. A. Fessenden as Head of the Department of Mechanical Engineering at the same institution.

Harold A. Everett has been appointed Associate Professor of Mechanical Engineering at The Pennsylvania State College. Professor Everett was graduated from Massachusetts Institute of Technology in 1902 and after a year of practical experience returned as a member of the faculty at M. I. T. where he remained until 1915. From 1915 to 1918 he was

Professor of Marine Engineering, post-graduate department, United States Naval Academy, and from the latter date has been Chief Engineer and Naval Architect, Union Shipbuilding Company, Baltimore.

University of Pittsburgh.—John Weber, Associate Professor of Mechanical Engineering, has been appointed Assistant to the Chancellor.

Walter W. Boyle, Assistant Professor of Mechanical Engineering, has been appointed Acting Associate Professor for the Academic Year.

W. C. Leinbach has been appointed Instructor in Mechanical Engineering.

Elmer E. Johnson has been appointed Instructor in Electrical Engineering.

Purdue University.—During July and August R. E. Wendt, of the Engineering Staff of Purdue University, visited 57 foundries of Indiana and interviewed 100 foundrymen in an effort to help them solve their problems. Mr. Wendt is an expert of extensive practical experience, and teaches foundry work in the Purdue University Engineering Schools.

The plants visited were very appreciative of the engineering extension work offered by Purdue and were delighted that this work has now been extended to the foundries of the state. Many of the foundrymen were in favor of holding a conference or meeting at Purdue University next spring.

A number of the foundrymen expressed their willingness to take Purdue students into their plants during the summer vacations.

An experimental transmission line for operation at 600 kilo-volts, the highest power line in the world, has recently been completed at Purdue University, Lafayette, Ind. This line is approximately one third of a mile in length and consists of three 600-ft. stans of steel core aluminum cable supported on steel towers 65 ft. high. Fifteen unit suspension

insulators are hung from carriages upon 40-foot channel iron cross-arms in such a manner as to be readily moved in a transverse direction while under strain of the cable. Tests may therefore be readily made with different spacings between cables. Two cables, sizes varying from No. 1 B. & S. to 500,000 cm., are used for a single-phase circuit upon which may be impressed voltages up to 600 kilo-volts at 60 cycles.

Two 300 kilo-volts, 135 K.V.A. Westinghouse transformers each with one terminal connected through a condenser bushing, and one terminal grounded, may have their secondary coils connected in series in order to provide 600 kilo-volts between line cables. Voltage is measured upon tertiary coils provided in the transformers which are calibrated with the A. I. E. E. standard sphere-gap. A crest voltmeter is also available for maximum voltage readings. The actual power being supplied to the line may be measured in the high voltage circuit, therefore, without introducing transformer losses. A short feeder, consisting of two 500,000 cm. cables widely spaced, reduces the tare losses to a minimum. These may be accurately measured and subtracted from the gross readings. The voltage is controlled by means of an auxiliary transformer and double-drum motor-driven controller which provide 480 equal steps, or voltage increments without distortion of wave form.

The steel towers are an adapted standard semi-flexible construction of the Bates Expanded Steel Truss Co., with special channel iron cross-arm and cross-arm truss. Intermediate towers are self-supporting, but end towers are provided with bridle guys of ⅝" steel extending to four points upon the cross-arm. Four standard types of suspension insulators were provided by the Locke, Ohio-Brass, Thomas and Jeffery-Dewitt Companies, while the cables were supplied by the Aluminum Company of America.

As little is known about the phenomena of corona losses above 220 kilo-volts, and as it is probable that voltages far

in excess of that value will be used for power transmission in the future, as the results of the further development of coal mines and hydro-electric power plants at great distances from available markets, it is believed that this line at Purdue University may prove of great value in these pioneer investigations.

Syracuse University: L. C. Smith College of Applied Science.—George Sims Parker, formerly of the University of Illinois, has been appointed Assistant Professor of Electrical Engineering.

Harold Raymond Myers, a graduate of Queen's University, has been appointed Instructor of Civil Engineering.

BOOK REVIEWS.

Mineral Land Surveying. JAMES UNDERHILL, U. S. Mineral Surveyor for Colorado. 237 pages, 4¼ x 7, 43 figures. John Wiley & Sons.

A standard work on the legal requirements, field detail and computations of surveys for mineral land patents in the United States. The Third Edition shows some improvements over those preceding. Among these are the rewriting of complete specimen field notes, so as to conform to current practice, the redrawing of many illustrations on a larger scale, enlargement of the discussion of methods of computation for direct solar observation and fuller treatment of the subject of errors. Application of the stadia method to location surveys is also treated more fully. Other portions of the work are substantially the same as in the earlier editions.

R. M. B.

Elements of Differential and Integral Calculus. WM. S. HALL.

This book is a rather brief treatment of the customary topics of a first course in calculus. In some respects the general appearance of the book reminds one of some of the older texts, such as Nichols.

The definition of "Limit," p. 4, is unfortunately stated. It appears to have been carried over from the definition in the older texts in elementary geometry. It is too restricted for general mathematical use.

There should be, in the opinion of the reviewer, more exercises at the end of Chap. 2.

The opening statement on p. 23 seems to give the impression that there are no transcendental functions except those mentioned. This would be very unfortunate, indeed.

While the method of limits is made the main basis of the treatment, there appear to be no concrete applications of this theory. This is unfortunate. But following the treatment of

"rates" is a very good list of applications. These applications the reviewer endorses and would enlarge.

The opening paragraph on p. 39 will hardly give the student a correct idea of the modern notion of a differential. Some delicate points of fundamental importance are left in the dark. It will not be easy for the student to rationally harmonize this paragraph with the opening paragraph of Chap. 5.

Without burdening this review with further details, it may be said the book is one of a class of texts in common use and in the hands of a careful and competent teacher can be used successfully. There is nothing distinctive, either in content or pedagogy; and in scholarship, even for a first course, it is hardly up to what a text of its grade should be in this day.

W. PAUL WEBBER.

PRELIMINARY PROGRAM FOR THE SECOND NATIONAL CONFERENCE ON HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT EDUCATION, WASHINGTON, D. C., OCTOBER 26, 27 AND 28, 1922.

Morning Session, October 26. Convene at 10 A.M.

1. "The Relation of Adequate Highway Transport Facilities to National Progress."
2. "The Relation of Adequate Highway Transport Facilities to National Defense."
3. "The Highway Engineering and Highway Transport Fields and Their Need for Trained Men."

Afternoon Session, October 26.

Committee meetings at 2 P.M. in designated rooms.

Evening Session, October 26. Convene at 8 P.M.

1. "Relation of Research to Highway Engineering and Highway Transportation."
2. "The Trend of Highway Engineering and Highway Transportation Education."
3. Discussion.

Morning Session, October 27. Committee Meetings at 9 A.M.

Afternoon Session, October 27. Committee Meetings at 2 P.M.

Evening Session, October 27. Convene at 8 P.M.

Symposium of Highway Educational Problems of the Future.

1. "Finance."

2. "Engineering and Administration."
3. "The Voice of the Road User."
4. "Highway Regulation."
5. "Correlation of Highway, Railroad and Waterway Transport."
6. "Transportation in Congested Districts."

Morning Session, October 28. Convene at 10 A.M.

Reports of Committees I, II, III, IV and V.

Afternoon Session, October 28. Convene at 2 P.M.

Reports of Committees VI, VII, VIII, IX and X.

Evening Session, October 28.

Dinner at 7:30 at New Willard Hotel.

1. Address:
2. Address:

COMMITTEES.

I. Required and Elective Undergraduate Subjects in Highway Engineering.

II. Required and Elective Undergraduate Subjects for Highway Transport Business and Engineering Positions.

III. Subject Matter of Basic Required Undergraduate Course in Highway Engineering.

IV. Subject Matter of Basic Undergraduate Course in Highway Transport.

V. Subject Matter of Undergraduate Course in Highway Engineering Theory and Design.

VI. Subject Matter of Undergraduate Course in Highway Engineering Laboratory.

VII. Nature and Content of Supporting Non-Technical Courses in Economics and English.

VIII. Graduate Work in Highway Engineering and Highway Transport.

IX. Conferences or Short Courses on Highway Engineering and Highway Transport.
X. Teaching Highway Traffic Regulation and Safety.

Object of the Conference.

To review the field of highway engineering and highway transport education in the light of the expanding State and Federal highway program and the rapidly increasing social and commercial use of the highways; to discuss general and special courses in undergraduate and graduate curricula; and to exchange views on educational trends arising from these developments in the national transportation system.

For the sake of simplicity and euphony, members of the Highway and Highway Transport Education Committee have voted by referendum to change its name to the Highway Education Board, it was announced here.

Although correctly understood among technical men, the name of the committee, popularized by various educational movements among schools and colleges, proved confusing and cumbersome, and the title, Highway Education Board, was chosen as the simplest that would express the purpose of the organization.

No change in the personnel of the board, nor in its functions, is contemplated, it was said. Dr. Tigert, who is United States Commissioner of Education, remains as chairman, while members of the board, as of the committee, continue to represent their respective organizations. Thomas H. MacDonald, chief of the Bureau of Public Roads, represents the Department of Agriculture. Colonel F. C. Boggs, Corps of Engineers, United States Army, represents the War Department. The National Automobile Chamber of Commerce is represented by Roy D. Chapin, president of a Detroit automobile company, while H. S. Firestone, president of an Akron tire company, is the delegate from the Rubber Association of America, being industry's other representative. The technical societies balance out the committee with Dean

F. L. Bishop, School of Engineering, University of Pittsburgh, from the Society for the Promotion of Engineering Education, and H. W. Alden, Detroit parts maker, from the Society of Automotive Engineers.

A continuation of its safety program, and a second national conference for the study of education for highway transport, engineering and economics are two outstanding events on the remainder of the year's program.